SEDIMENT TRANSPORT ANALYSIS REPORT

HATCHIE RIVER BASIN SPECIAL STUDY

TENNESSEE AND MISSISSIPPI

PREPARED BY

U.S. DEPARTMENT OF AGRICULTURE'S
SOIL CONSERVATION SERVICE
FOREST SERVICE

JULY 1986

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INTRODUCTION

This sediment transport analysis report is one of three documents resulting from the Hatchie River Basin Special Study. A sediment transport model was developed to show the effects of erosion and sediment in and along the main stream of the Hatchie River.

An accelerated land treatment plan for the Tennessee portion of the basin and a hydrologic analysis report covering the entire basin were also developed as a part of the overall study. This study was authorized and conducted under the provisions of Public Law 83-566 by the Soil Conservation Service. Assisting with the study were the Tennessee Department of Conservation (study sponsor), the Economic Research Service, Forest Service and numerous other Federal and state agencies and organizations.

The Hatchie River Basin Special Study was preceded by a United States Department of Agriculture (USDA) comprehensive river basin, Type IV study completed in 1971. The initial river basin study report emphasized that problems resulting from excessive erosion and sedimentation were the basin's most serious resource-related problems. It also recommended that a basin-wide accelerated land treatment plan be developed and implemented.

The Tennessee Department of Conservation organized an interagency task force in December 1975 to initiate implementation of a Hatchie Scenic River Project. This action was taken after the Tennessee portion of the Hatchie River was designated as a Class I Natural River by the Tennessee General Assembly. The task force, consisting of representatives from 13 concerned organizations and state and Federal agencies, recommended that studies be initiated to specifically assess erosion, sedimentation and flooding and to analyze the main stem impacts incurred and anticipated as a result of land and water management projects and activities.

The Commissioner of the Tennessee Department of Conservation requested in June 1977 that the Soil Conservation Service and other agencies of the USDA conduct a special river basin study of the Hatchie River Basin. The requested study was authorized in January 1982 after a plan for conducting the study was developed and approved in late 1981.

Several technical terms are used in this document that may be unfamiliar to some readers. Selected definitions are provided in the Glossary.

SUMMARY OF FINDINGS

Sediment transport analysis on the Hatchie River main stream was conducted using 1982 erosion inventory data, the discharge from the mean annual or 2.33 year frequency flood and the Schoklitsch Bedload Equation.

The effects of watershed projects on erosion and sediment transport were compared to the same erosion conditions without projects in place. Bedload and suspended load reductions of 43 percent and 50 percent, respectively, were achieved on the main stream down to Valley Section 50 shown on Study Report Map in Appendix A. The high level of control by watershed project floodwater retarding dams makes these reductions possible. The effect of projects below VS 50 is negligible and little reduction is noted. The sediment reduction expected from Porter's Creek at VS 45 was not achieved because of excessive channel erosion within Porter's Creek project. Main stream channel aggradation remains a major problem with all projects installed and present excessive upland erosion uncontrolled.

Projected future channel conditions indicate severe aggradation unless measures for erosion control are implemented.

BASIN DESCRIPTION

The Hatchie River Basin is located in southwestern Tennessee and northern Mississippi. The river begins in Mississippi and is joined near the Tennessee-Mississippi state line by the Tuscumbia River. A total of 36 major creeks join the river as it flows from the state line north-westerly across Tennessee to its outlet at the Mississippi River, 35 miles north of Memphis. The drainage area is about 110 miles long and averages about 24 miles wide, with a total acreage of 1,664,600 acres. Twenty-eight percent of the basin is in Mississippi including parts of Alcorn, Benton, Prentiss, Tippah and Union Counties (General Location Map). In Tennessee, the basin includes parts of Chester, Fayette, Hardeman, Haywood, Lauderdale, Madison, McNairy and Tipton Counties. The basin lies within two major land resource areas (MLRA) (General Location Map). It is about equally divided between the Southern Mississippi Valley Silty Uplands (MLRA 134) and the Southern Coastal Plain (MLRA 133). The two areas are distinctly different in their resource characteristics. Sixty-five percent of the basin's forests occur in the MLRA 133, while 66 percent of the croplands and 57 percent of the pasturelands occur within MLRA 134.

Topography of MLRA 134 is a sharply dissected plain with a thick loess mantle underlain by unconsolidated sands, silts and clays of marine origin. MLRA 133 is a gently to strongly sloping dissected plain with the same underlying formations. Stream valleys are narrow in upstream reaches, but the lower parts of the valley are broad and have widely meandering stream channels.

The basin includes primarily two geologic physiographic provinces: the West Tennessee Uplands and the West Tennessee Plain. The eastern one-third of the basin lies within West Tennessee Uplands, which is dissected and hilly, with some belts of rolling topography. Localized swamp

GENERAL LOCATION MAP
HATCHIE RIVER BASIN
TENNESSEE AND MISSISSIPPI

conditions are present along many of the streams. Elevations range from 400 to 700 feet mean sea level. Most of the remainder of the basin lies within the West Tennessee Plain, which slopes gently westward from an elevation of 400 feet to 300 feet mean sea level. Topography is gently rolling, interrupted by small ridges and drainage divides. Some gullied topography has developed. Accelerated swampy conditions in the flood plain have resulted from erosion and the subsequent deposition of sediment.

The two physiographic provinces make up a portion of the eastern half of a larger geologic unit known as the Mississippi embayment of the Gulf of Mexico Coastal Plain. The Mississippi embayment now forms a trough filled with the old gulf sea sediments. The trough plunges to the south and follows the course of the Mississippi River. An arm of the gulf sea occupied the embayment for millions of years, and several thousand feet of sediment was deposited. Geologic units from Upper Cretaceous to Quaternary were deposited in the basin. Subsequent erosion has exposed these units. The formations consist primarily of gravel, sand, silt and clay. Windblown silt deposited in the Quaternary Age covers the western two-thirds of the area. The deposits of gravel and sand now form vast water-bearing aquifers, which produce large quantities of water.

The geologic formations strike north-northeast to south-southwest and dip to the west-southwest as shown on the geologic map (Appendix A). They are important in regard to the Hatchie Basin as several formations outcrop in the eastern one-third of the area and together with surface soils provide rapid rain infiltration. The result is several aquifers of abundant, high quality ground water supplies. Storm runoff is also reduced by this ground water infiltration.

The highly erosive nature of soils in the basin is directly related to soil formation from geologic materials. The following is a description of the general soil map units shown on the soils map (Appendix A):

1 - Memphis-Loring - This unit is mostly hills and ridges. The ridge-tops are narrow, winding and long. Crooked drains form deep, narrow valleys. The nearly level strips in the valleys are seldom more than 200 feet wide. The steep hillsides are most conspicuous. They have a slope range of 15 to 50 percent. The soils formed in deep silty deposits and are naturally fertile. Memphis soils are deep and well drained. Loring soils are moderately well drained and have a compact layer (fragipan) at a depth of approximately 28 inches.

About 80 percent of this unit is forest, and most of this is on the steeper slopes. The soils on the more gentle slopes are suited to a wide variety of crops. This unit has serious limitations for agriculture, because of the steep slopes and high erosion hazard of the soils. It has some limitations for residential and industrial development because of steep slopes.

2 - Grenada-Loring-Memphis - This unit is predominantly undulating to rolling. It consists of broad ridges that are gently sloping with strongly sloping side slopes and many small drainageways. The soils of this unit formed in silty deposits ranging from 5 to more than 20 feet

thick. The moderately well drained Grenada and Loring soils have a compact fragipan layer at a depth of about 24 inches except in severely eroded ares where the depth to the fragipan is 18 inches or less. Severe damage from past erosion is common on the more sloping parts of the unit that have been used intensively for crop production. Approximately 80 percent of this unit has been cleared and used primarily for field crops such as cotton, soybeans, corn, hay crops and small grain. Only a small part is in pasture or forest.

3 - Falaya-Waverly-Collins - This unit forms the alluvial flood plains of the Hatchie River and its tributaries. All of the soils are subject to flooding, most commonly in winter and spring. The soils are silty and fertile. The Falaya and Waverly soils are not too wet for growing corn and soybeans if drainage is provided. About 75 percent of this unit is forest and produces many species of trees. These soils are highly responsive to management and well suited for wetland wildlife habitat. They have serious limitations for housing developments and road construction because of flooding, low strength and wetness.

4 - Memphis-Loring-Lexington-Smithdale - This unit is moderately dissected with narrow gently sloping ridgetops; steep side slopes and narrow bottoms along the many drainageways. The Memphis, Loring and Lexington soils are on the ridges where they formed in silty materials that range from 3 to 6 feet thick over unconsolidated loamy sediments. The Smithdale soils developed in loamy sediments on the steep hillsides. These soils are all well drained except Loring, which is moderately well drained. Severely eroded areas and gullies are common in this unit, especially on the steeper slopes. The gently sloping ridges and narrow bottoms are suited for crops such as cotton, soybeans, corn and pasture. Many small severely eroded areas are idle or reverting to woodland. Most of the steeper slopes are forested.

5 - Ruston-Cuthbert-Providence - This unit is predominantly hilly, with long, rolling ridges; long, steep and very steep side slopes and narrow stream bottoms. Ruston and Cuthbert soils are well drained. Providence soils are moderately well drained with a fragipan layer about 24 inches below the surface. Providence soils are on the rolling ridgetops. Ruston soils are on the ridgetops and on the upper part of the slopes. Cuthbert soils commonly are on the lower part of the side slopes. The ridgetops and the stream bottoms are suited to corn, cotton and soybeans and are moderately productive for these crops. Many of the steep side slopes have never been cleared of trees. Some areas that were cleared and plowed now have deep gullies. Many of the side slopes that were cleared are reverting to trees.

6 - Wilcox-Dulac-Falkner - This unit consists of wide, nearly level ridges, short side slopes and narrow stream bottoms. The ridges are several miles long and are mostly one-eighth to one-half mile wide. The gradient of the side slopes between the ridges and the stream bottoms is generally less than 17 percent. The moderately well drained Dulac and somewhat poorly drained Falkner soils are on the ridgetops. They formed in a silty mantle 1.5 to 3 feet thick and the underlying clayey Coastal Plain sediment. The well drained Wilcox soils formed in clayey sediment

and are on the side slopes. Most of the unit has been cleared of trees and has been row cropped at some time. The ridgetops and the stream bottoms are suited to, and moderately productive for cotton, corn and soybeans. The steeper side slopes are not cultivated now and are reverting to trees. These soils have serious limitations for roads and buildings, because they shrink and swell with changes in moisture content.

The average annual rainfall over the basin is about 52 inches. October is the driest month, with an average of nearly 3 inches, and January is the wettest month averaging over 6 inches. About 59 percent of the annual rainfall occurs during the months of April through November. Generally, the winter rains are of several days in duration and extend over broad areas, but ordinarily the intensity is not severe. Rains of this type have caused the maximum floods to occur on the Hatchie River. Summer rains are usually of the thunderstorm type, with higher intensities, but cover smaller areas. Rains of this nature often cause flash flooding on tributaries of the Hatchie River. Monthly rainfall has ranged from a high of 19.4 inches in January 1937, to a low of 0.3 inches in September 1953. The average annual snowfall is approximately 4 inches. Snow seldom stays on the ground for more than a day or two at a time.

Agricultural lands, including forests, occupy 86 percent of the basin (approximately 1,430,780 acres). Of these, approximately 35 percent (504,690 acres) is cropland, 16 percent (230,010 acres) is grassland, and 49 percent (696,080 acres) is forest land. Other land occupies 14 percent (233,820 acres). Table A displays major land use for upland and bottomland by state.

TABLE A - MAJOR LAND USES BY UPLAND AND BOTTOMLAND

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Land Use	Upland			Bottomland			Basin
	Tennessee	Mississippi	Total	Tennessee	Mississippi	Total	Total
Cropland	337,870	96,840	434,710	48,720	21,260	69,980	504,690
Grassland	155,110	50,960	206,070	18,900	5,040	23,940	230,010
Forest Land	343,250	227,480	570,730	94,330	31,020	125,350	696,080
Other	159,970	22,530	182,500	36,920	14,400	51,320	233,820
Totals	996,200	397,810	1,394,010	198,870	71,720	270,590	1,664,600

Source: Soil Conservation Service Data

The forest land covers 42 percent of the basin. Eighty-two percent of the forest is in the upland, with the remaining 18 percent in the bottomland. The upland species include shortleaf and loblolly pine, red cedar, red and white oak groups, hickories, yellow poplar and sweetgum. The bottomland species are ash, cottonwood, black gum, tupelo and willow.

Forest and agricultural industries are important to the basin's economy. Numerous wood-using industries are located throughout the basin. Sawlogs, fuel wood and pulpwood are the primary forest products. Other products include veneer logs, poles, posts and miscellaneous industrial wood.

The most important row crops grown are soybeans, cotton, corn and wheat. Cattle, hogs, poultry, dairy and orchards are also important agricultural enterprises.

Population has fluctuated around 125,000 since 1930. The urban sector has almost tripled during this period. It is estimated that approximately 75,000 persons currently live in rural areas; and approximately 50,000 persons live in urban centers. Corinth, located in Alcorn County, Mississippi, is the basin's largest city. Other sizeable cities or towns include Selmer, Brownsville, Bolivar, Covington and Ripley, Tennessee.

RELATION TO OTHER STUDIES

The three-part Hatchie River Basin Special Study follows the Hatchie River Basin Survey Report of 1971. It also follows the Obion-Forked Deer and the Public Law 87-639 Wolf-Loosahatchie Comprehensive River Basins studies and builds on the expertise gained from these two studies in the area of land treatment planning. The overall study complements ongoing programs, including Public Law 83-566 watershed, resource conservation and development (RC&D), and water quality (PL-92-500, sec. 303 and 208) projects and planning efforts in Tennessee and Mississippi. It also complements the effort of the West Tennessee Erosion Control Program.

Data from the Hatchie River Basin Survey Report of 1971 has been updated by the use of the National Resource Inventory (NRI) Survey of 1982. More intensive NRI data collection was utilized in the Tennessee Counties to provide a statistically valid sample base. Inventory data for the Mississippi portion comes from the Mississippi Statewide Cooperative River Basin Study and recently updated watershed plans.

MODEL DESCRIPTION AND METHODOLOGY

The sediment transport analysis follows the procedure required for valid model analysis as outlined in Chapter 4 of the SCS National Engineering Handbook and illustrated in Chapter 9 of the South National Technical Center's Technical Release 12. The procedure was developed primarily for channel stability analysis as related to the transport capacity of the stream system. Prediction of aggradation or degradation can be made by studying the various levels of erosion control and sediment deposition. The sediment transport analysis was developed to display the sediment transport capacity of the main stream of the Hatchie River.

Several equations or models are available depending upon the type of sediment being considered. The three principal equations in present use are as follows:

The Meyer-Peter Equation for sediment sizes ranging from coarse sands through coarse gravels.

The Schoklitsch Equation for medium sands through fine gravels.

The Haywood Equation for fine sands through medium sands.

The specific equation or model used in this study is the Schoklitsch Equation. Basic data requirements in terms of engineering surveys, hydrologic data, erosion inventories and sediment delivery ratios are the same for each equation.

The model analysis shows the amount of sediment delivered to each main stream reach by the mean annual or 2.33 year flood and the ability of the system to transport this sediment volume to the next reach downstream.

The following outlines the recommended data requirements presented in the aforementioned procedures and follows SCS - Technical Guide 12, Chapter 9 (TG 12).

The stream is divided into selected reaches and identified by surveyed valley sections, channel cross sections and profiles related to mean sea level (MSL). These reaches and valley sections are shown on the Study Report Map in Appendix A. Valley sections were surveyed across the mouth of each tributary and on the main stream, both upstream and downstream from each tributary mouth and at all bridge crossings and other significant changes in stream regime. These surveys are required for the hydrologist to provide the following data for the selected transport model using the mean annual flood (2.33 year frequency).

1. Drainage area of each tributary and cumulative drainage area on the main stream as flood routing progresses downstream.

2. Discharge for each tributary and each reach as routing progresses downstream.

3. Water surface profile is developed for the entire main stream.

The Schoklitsch Bedload Transport Equation computes the transport capacity of each main stream reach incrementally from upstream to downstream as storm runoff (2.33 yr.) and sediment delivery from each tributary are added. As originally designed, the equation-computed aggradation or degration as a result of uncontrolled runoff plus release flows from dams as the first analysis. The second analysis computed these same effects from release flows only. For purposes of this study, the first analysis considers runoff as all areas are uncontrolled (no projects) and the combined runoff from controlled plus uncontrolled as the second analysis.

The solution to the equation $q_s = 86.7 \frac{S^{3/2}}{D^{1/2}} \left(q - 0.00532 \frac{D}{S^{4/3}}\right)$

will show the cumulative sediment loading for each reach as routing

progresses downstream and sediment transport capacity of each reach, where:

q_s = sediment transport capacity of a channel in pounds per second per foot (lbs/ft) of channel bottom width.
S = Slope of the hydraulic gradient in feet per foot (ft/ft).
D = Representative diameter of bed material in millimeters (mm).
q = Discharge, in cubic feet per second (ft^3), per foot of channel bottom width.

These data and analysis provide estimates of main channel effects for each of the following conditions:

1. Present gross erosion without any watershed projects.
2. Present gross erosion with all authorized watershed projects installed as planned. (Fig. 4)
3. Future (25 years) gross erosion reduced 9 percent from the present by ongoing programs under both conditions 1 and 2. (Fig. 5)
4. Future (25 years) gross erosion reduced 66 percent from the present by the implementing of the proposed Hatchie River Basin Land Treatment Plan under both conditions 1 and 2. (Fig. 6)

Average annual suspended sediment load is also analyzed for each condition using the procedure in SCS - TG 12, Chapter 8.

GROSS EROSION DATA

Sediment transport analysis of a stream system begins with the total volume of annual average erosion in the watershed. The percent of this erosion delivered to the stream system, along with the runoff from the mean annual storm, form the basis of the sediment transport analysis.

Erosion data in the Mississippi portion was developed from inventories for watershed studies and from appropriate data in the Mississippi State-Wide Cooperative River Basin Study. Data from the 1982 National Resource Inventory and special inventories of large gullies, roadbank erosion and ephemeral gully erosion on cropland were used in the Tennessee portion. Table A shows land use with approximately 84 percent classified as upland and 16 percent as bottomland.

As noted in Table B, cropland clearly is the major erosion problem area and sediment source in the basin. Total erosion is estimated at 19,229,930 tons annually with 16,653,400 tons or 87 percent occurring on cropland. Approximately 56 percent of the cropland erosion occurs on capability subclasses IVe, VIe and VIIe.

Land use is an important factor in determining erosion sources and volumes. Figure 1 shows land use by percent in uplands, and Table B shows erosion by source area. The percent of gross erosion attributed to each of these sources is illustrated in Figure 2. Upland cropland is only 31 percent of the total upland area, but contributes 87 percent of the total erosion. Ephemeral gully erosion is 48 percent of this cropland erosion.

FIGURE 1 - LAND USE IN UPLANDS

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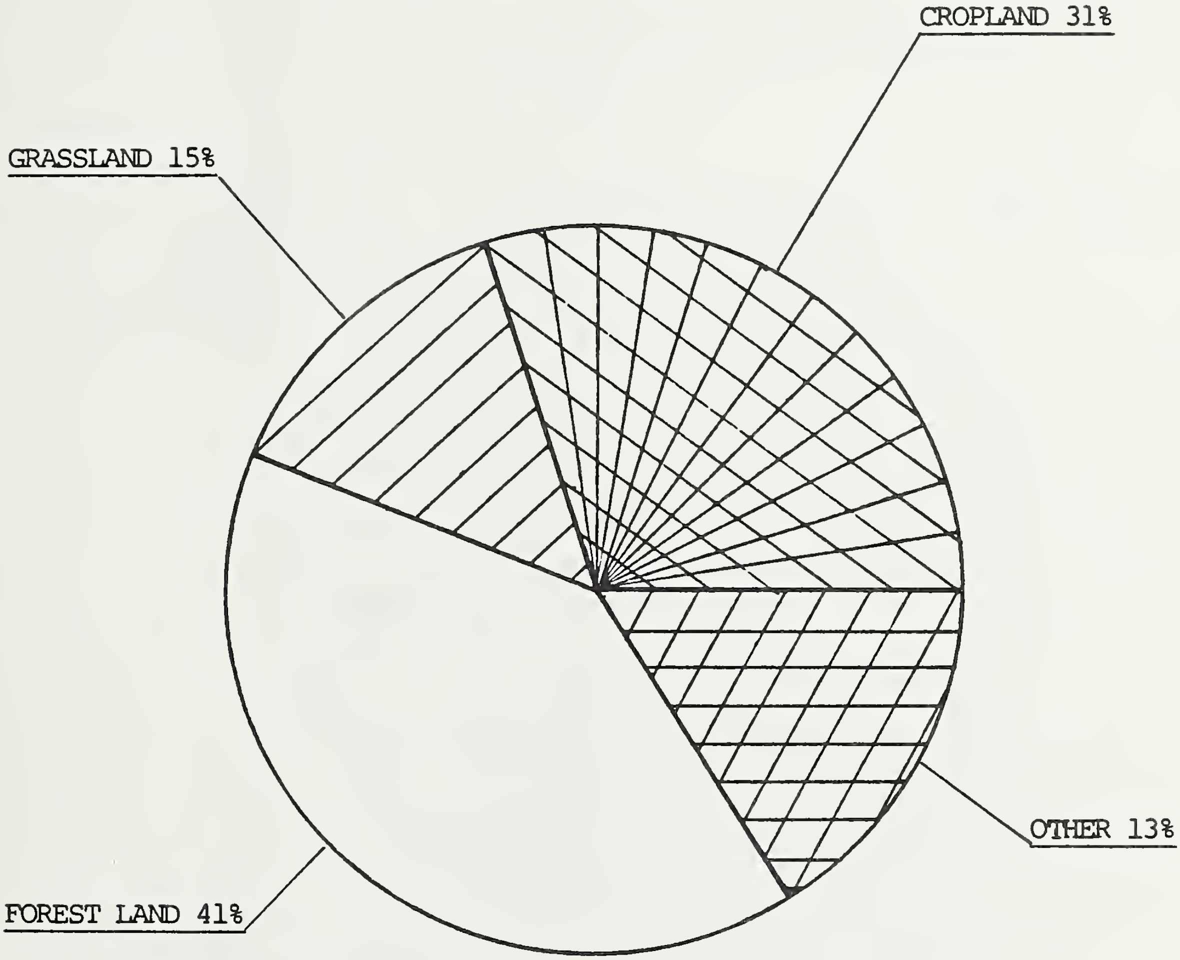

Source: NRI Data, Watershed Plans and the Mississippi State-Wide Cooperative River Basin Study

FIGURE 2 - UPLAND GROSS EROSION BY LAND USE

(19,229,930 Tons Annually - Average 12 Tons/Acre/Year)

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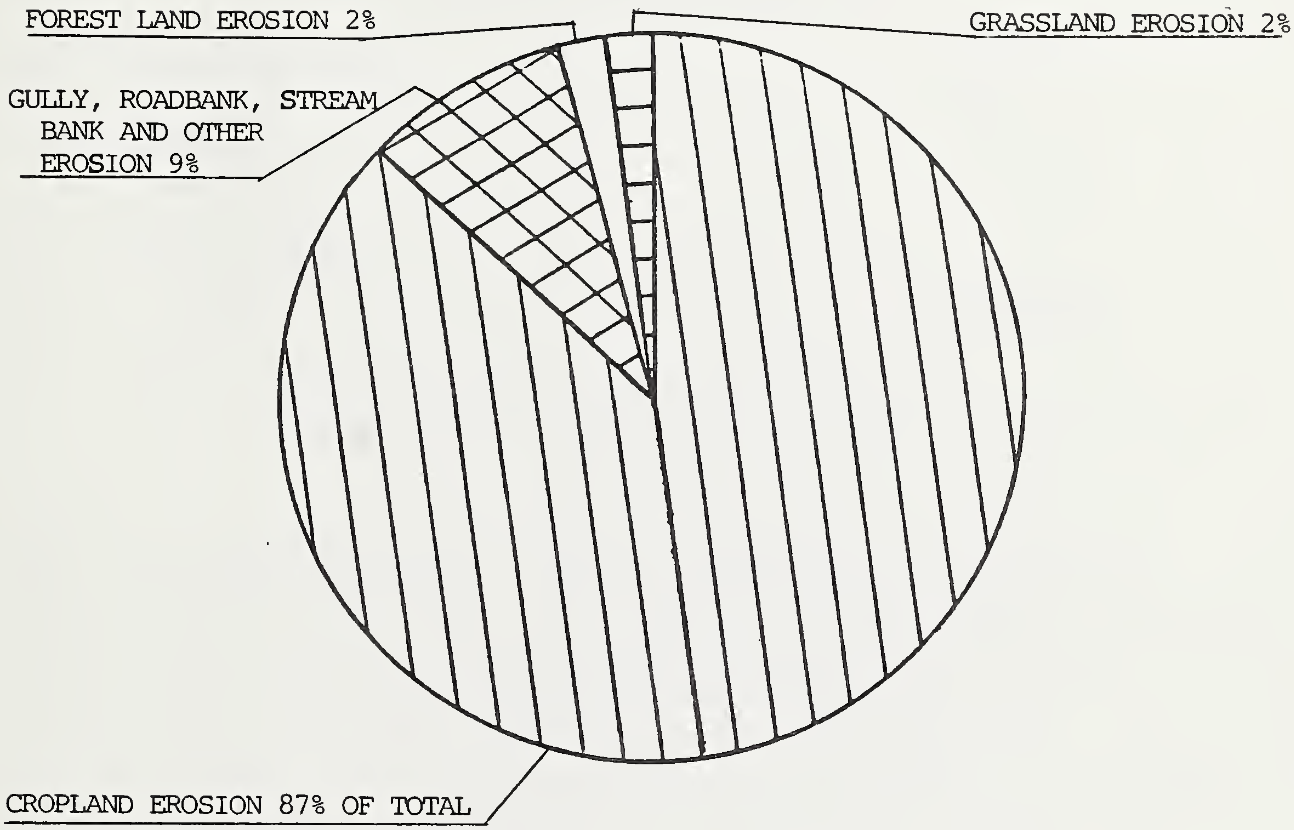

Source: NRI Data, Watershed Plans and the Mississippi State-Wide Cooperative River Basin Study

Grain size distribution of bed load and wash load were derived from upland and bed load samples collected and analyzed in prior Public Law 566 watershed projects. The percentage of sediment transported as bed load and suspended load were estimated from these samples and upland soils composition and distribution.

TABLE B - UPLAND GROSS EROSION BY LAND USE

Sediment Transport Analysis Report
Hatchie River Basin Special Study
Tennessee and Mississippi

Land Use	Tons Per Year
Cropland	16,653,400
Grassland	428,130
Forest Land	292,500
Horticulture	7,000
Gully, Roadbank, Streambank and Other	1,848,900
Total	19,229,930

Source: NRI Data, Watershed Plans and the Mississippi State-Wide Cooperative River Basin Study

LAND DAMAGE

Excessive erosion results in off-site problems identified as damages which result from sediment deposition. Infertile deposition and swamping due to sediment-filled channels result in crop, pasture and timber damages. Excessive sediment loading on stream systems also impairs water quality and aquatic life. Average annual damages to bottomland crops and pasture are estimated at $566,000 dollars (1982) and affect 45,400 acres. Additional damages occur on bottomland forest and affect dredging costs in the Mississippi River. An estimated 2,000,000 tons of sediment are delivered annually to the Mississippi River. The damages to the hardwood timber in the dead and fading areas are from ponded water and sediment deposits. It is very hard to ascertain the primary causes of the timber damages, but the two major contributing factors are impaired drainage (swamping) from channel filling and the effects of beaver activities. Over 93 percent of the bottomland hardwoods are classed as live. The dead and fading timbered areas amount to 5 percent, and the remaining 2 percent are in the regenerated class.

The dead and fading acreage in 1980 amounted to 5,435 acres and 2,984 acres, respectively, with a total of 8,419 acres. The stumpage value of the affected timber was determined using $145 (Doyle Log Scale) as the average stumpage price per thousand board feet for West Tennessee for bottomland hardwood sales during the spring of 1985. The average volume of hardwood timber was 3,799 board feet per acre (Doyle Log Scale). Almost 32 million board feet of hardwood timber was affected in the dead and fading class. The monetary amounts in both classes were based on values for live timber rather than its reduced value as dead and fading timber. The monetary loss in dead timber was $2,993,900 and $1,643,750 in the fading class. The total monetary loss amounted to $4,637,650, an average of $550 per acre.

TRANSPORT ANALYSIS

The purpose of the sediment transport analysis is to show the transport capacity of each reach of the main stream Hatchie River to move bedload sediment. The portion of upland gross erosion estimated to be bedload delivered to the main stream and the bedload transport capacity of the runoff from the mean annual storm are compared. Estimates of bed load volumes were based on upland soil types, erosion sources and delivery to the stream system. The transport capacity and the sediment load are introduced in the model equation at the uppermost reach of the stream and brought progressively downstream. If the estimated volume of bedload exceeds the transport capacity of the storm discharge, channel filling or aggradation will occur. The transport capacity is subtracted from the incoming bedload to determine the amount of aggradation and the portion of the load transported into the next lower reach. The bedload transported to the next reach is added to additional incoming sediment and is then compared with the transport capacity in that reach, and so on downstream through each reach to the mouth of the river.

If the transport capacity exceeds the incoming bedload, volume degradation can be expected. If degradation is predicted, the amount of sediment degraded from one reach is equal to the transport capacity of that reach, less the incoming bedload.

By using this approach, aggradation and/or degradation can be estimated, reach by reach, for any stream that carries a significant bedload. This procedure was used to analyze the effect the four conditions presented on page 12 will have on the Hatchie main stream from the headwaters to the mouth.

As pointed out under "Model Description and Methodology", the volume and duration of the 2.33 year frequency flood provides major basic inputs in the model analysis. Therefore, it is important to understand the runoff effect of this flood. It is representative of the effect of the Public Law 566 watershed projects on sediment deposition. The runoff effect or flooding for conditions 1 and 2 are shown in Appendix B, Figure 3. Overbank flood depths from 3 to 5 feet occur under condition 1 throughout the main stream. These depths are reduced approximately 1 foot by the installation of all projects under condition 2. No significant flood reductions occur as a result of the erosion control plans listed as conditions 3 and 4, therefore, they are not displayed.

As shown on Table C, watershed project installation (condition 2) increases the "Duration or Time of Flow" of storm runoff. The release rate from floodwater retarding dams combined with runoff from uncontrolled drainage areas significantly increases runoff time and transport capacity. Duration on Table C increases approximately 38 percent at VS 135 to 13 percent at VS 12. The area of significant drainage area control by projects is from VS 135 to VS 50 (Muddy Creek). The high level of control down to VS 50, results in an average transport capacity increase of 95 percent, but the beneficial effect of watershed projects diminishes to no effect from Muddy Creek downstream to VS 12. The cumulative effect of projects upstream from VS 50 reflects a reduction of sediment deposition in the main stream channel, but aggradation continues with all projects installed. The annual rate of deposition and the effect of present and future conditions is shown on Table D and on Figures 4, 5

TABLE C - DURATION OF FLOW AND TRANSPORT CAPACITY - PRESENT CONDITION

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Channel Section	Watershed Increment	Duration of Flow No Projects dd Sec.	Duration of Flow Projects dd Sec.	Transport Capacity No Projects Pounds	Transport Capacity Projects Pounds
		--------1,000--------		----------1,000--------	
135	Tuscumbia	599.4	972.0	83.9	2,347.4
147	McNairy Cypress	594.0	915.3	475.2	7,642.8
53	Upper Hatchie	702.0	915.3	312.4	6,272.6
550	Moses Nail	729.0	918.0	115.2	6,962.1
50	Muddy	729.0	918.0	224.6	8,049.9
46	"Group"	804.6	937.8	2,606.1	2,222.6
45	Porters	815.4	937.8	10,950.8	10,372.1
44	Cub	780.3	945.0	11,236.3	10,206.0
41	Piney	805.5	946.8	11,518.7	10,414.8
40	Spring	850.5	981.0	13,888.7	12,537.2
37	Gray's - Pleasant Run	895.5	1,071.0	12,895.2	12,530.7
35	Short/Mill	936.0	1,102.5	15,752.9	13,119.8
34	Clover	997.2	1,174.5	18,667.6	14,375.9
33	Hickory	1,044.0	1,201.5	18,123.8	13,408.7
31	Pinner	1,089.0	1,264.5	19,536.7	13,960.1
30	Jeffers	1,093.5	1,260.0	21,192.0	15,422.4
29	Shaw	1,170.0	1,372.5	20,884.5	14,411.3
28	Bear/Carter's	1,228.5	1,327.5	22,407.8	16,567.2
26	Sugar	1,237.5	1,413.0	11,583.0	6,612.8
24	-	1,237.5	1,368.0	22,844.3	15,540.5
22	Poplar	1,237.5	1,413.0	22,286.3	14,130.0
21	Muddy	1,309.5	1,468.8	26,203.1	17,890.0
20	Cypress	1,350.0	1,490.4	11,772.0	6,498.1
18	Lagoon/Camp	1,417.5	1,555.2	12,502.4	5,878.7
17	Williams	1,458.0	1,625.4	12,859.6	7,964.5
16	--	1,462.5	1,609.2	12,080.3	7,595.4
12	Henning	1,440.0	1,663.2	13,622.4	8,582.1

Source: SCS Data Base

TABLE D - AVERAGE ANNUAL SEDIMENT DEPOSITION BY REACHES

Sediment Transport Analysis Report
Hatchie River Basin Special Study
Tennessee and Mississippi

Valley Section [1/]	Tributary Watershed	Stream Miles	PRESENT CONDITION: N.P. [3/] Bedload Deposition Tons Per Year	PRESENT CONDITION: W.P. [4/] Bedload Deposition Tons Per Year	PRESENT CONDITION: N.P. Suspended Load PPm	PRESENT CONDITION: W.P. Suspended Load PPm	FUTURE CONDITION: N.P. Bedload Deposition Tons Per Year	FUTURE CONDITION: W.P. Bedload Deposition Tons Per Year	FUTURE CONDITION: N.P. Suspended Load PPM	FUTURE CONDITION: W.P. Suspended Load PPM	HATCHIE LAND TREATMENT PLAN: N.P. Bedload Deposition Tons Per Year	HATCHIE LAND TREATMENT PLAN: W.P. Bedload Deposition Tons Per Year	HATCHIE LAND TREATMENT PLAN: N.P. Suspended Load PPM	HATCHIE LAND TREATMENT PLAN: W.P. Suspended Load PPM
135 [2/]	Tuscumbia	0	48,300	24,700	610	330	43,800	22,300	560	300	43,800	22,300	560	300
147	McNairy Cypress	7.0	18,900	4,700	550	270	17,000	4,000	490	240	6,400	-100	410	210
53 [2/]	Upper Hatchie	8.4	35,500	26,300	520	290	32,200	23,900	420	270	32,200	23,900	410	250
550 [2/]	Moses/Nail	10.7	9,200	8,700	540	320	8,300	7,800	480	290	3,200	2,800	400	250
50	Muddy	12.4	16,200	8,700	530	310	14,600	7,800	470	280	14,600	7,800	410	250
46	--	20.6	12,100	16,200	530	330	10,800	14,900	470	300	3,400	7,500	400	240
45	Porter's	40.8	32,900	31,500	540	300	29,800	29,200	480	270	8,800	8,600	370	220
44	Cub	43.5	3,630	1,200	540	300	3,300	1,200	490	270	1,200	500	370	220
41	Piney	50.0	15,500	15,600	560	320	14,100	14,100	500	290	5,300	5,300	370	220
40	Spring	56.9	23,200	23,400	550	330	20,900	21,100	490	300	7,200	7,400	350	220
37	Grays	64.4	12,800	12,300	570	350	11,700	11,700	510	320	5,100	4,600	360	220
35	Short/Mill	69.8	-387	750	560	350	-480	650	500	320	-1,100	70	350	220
34	Clover	77.3	9,200	10,000	530	340	8,200	9,000	480	310	2,200	3,000	330	210
33	Hickory	85.3	5,000	5,200	520	330	4,500	4,800	470	300	1,900	2,100	320	200
31	Pinner	90.0	32,200	32,600	560	380	29,100	29,500	500	340	10,700	11,100	330	220
30	Jeffers	97.3	30,900	31,000	590	410	27,900	28,000	530	380	10,110	10,200	340	230
29	Shaw	106.2	15,900	16,200	610	430	14,400	14,700	550	390	5,600	5,900	340	230
28	Carter's/Bear	111.0	62,800	57,300	670	490	56,800	52,800	600	450	21,200	19,400	360	250
26	Sugar	120.4	33,300	32,900	690	520	30,700	30,300	620	470	21,000	20,600	360	250
24	--	123.4	1,700	2,800	700	530	1,000	2,100	630	480	-730	440	360	250
22	Poplar	129.6	69,100	69,000	750	590	62,600	63,100	680	530	2,400	24,500	370	270
21	Muddy	134.8	31,500	31,600	820	620	28,400	28,500	700	560	9,600	9,700	380	280
20	Cypress	142.1	44,500	43,000	810	650	41,000	39,500	730	590	20,100	18,600	390	290
18	Lagoon/Camp	147.7	44,100	44,800	840	690	40,000	40,600	750	620	15,000	15,700	390	300
17	Williams	153.9	33,000	32,100	860	710	29,800	29,000	770	650	11,300	10,400	400	310
16	--	157.5	17,900	17,700	870	720	16,300	16,100	780	660	6,500	6,240	400	310
12	Henning	162.1	13,500	13,800	880	730	12,200	12,500	790	670	4,200	4,400	410	320

1/ All valley sections on main stream - just downstream from tributary
2/ Does not include recommended Hatchie River Basin Land Treatment Plan
* Positive numbers indicate aggradation and negative numbers degradation
3/ (N.P.) No Projects
4/ (W.P.) With Projects

Source: SCS Data Base

and 6 in Appendix B. These figures compare the rates of deposition for with and without project installation using present erosion rates and also compare future conditions. The deposition rate is reduced 60 percent from VS 135 to VS 50 by projects, but channel capacity is still being lost at a rate of 0.2 to 0.3 feet per year. Slight reductions in deposition can be achieved by future ongoing programs with very significant reductions possible by implementing the recommended land treatment plan.

The stream regime approaches near equilibrium under the recommended land treatment plan with slight degradation indicated at VS 35 and VS 24 resulting from a 65 percent reduction in gross erosion. The recommended land treatment plan meets the objective of a Resource Protection Plan by reducing erosion to an acceptable level to maintain the upland soil resource base.

Study of the gross erosion problem areas throughout the basin directed particular emphasis to Porters Creek Watershed Project. This watershed outlets into the Hatchie River at VS 45, approximately 28.4 miles downstream from Muddy Creek. Lack of project control in this reach allowed increased aggradation. In addition, excessive channel bank erosion from Porters contributed large volumes of sediment to the Hatchie River in a rather brief number of years. This sediment volume significantly increased the problem of aggradation in the reach from VS 45 to VS 44. The sediment load reduction normally expected as a result of project installation was offset by the increase in channel erosion.

Vertical accretion of varying depths is found throughout the stream system, with greater depths of deposition occurring upstream from bridges, beaver dams or activity, logging operations and natural tree mortality. Any of these conditions increase deposition on the upstream side and scour to some depth and distance downstream. Surveyed channel sections defined scour holes below most bridges, with greater deposition immediately downstream from these holes.

Thus far the analysis has considered only bedload and the channel transport capacity for the heavier coarse part of the sediment which constitutes the bedload. The effect of watershed projects on suspended sediment load must also be considered. Table D, also shows the average annual suspended sediment load before and after project installation, as well as effects of future conditions as set forth in conditions 3 and 4. Reductions in suspended sediment load by projects range from 46 percent at VS 135 to 17 percent at VS 12 under present conditions.

CONCLUSION AND RESULTS

Watershed projects are located primarily in the headwaters of the Hatchie Basin, upstream from Cub Creek at VS 44. The greatest effect of these projects is in this immediate area. Comparison of the present erosion (condition 1) without watershed projects installed to this same level of erosion with projects installed shows a slight reduction in flooding. Overbank flood depths from the mean annual flood are reduced approximately 1 foot on the main stem to VS 44. Floodwater reductions of slightly less than 1 foot continue downstream to VS 12 as a result of project installations, but overbank flood depths of 3 to 4 feet remain.

Bedload sediment deposition is reduced approximately 55,000 tons or 43 percent annually downstream to VS 50. Suspended sediment load is reduced from 50 percent to 42 percent in this area. Bedload deposition

increases from 544,000 tons to 641,000 tons annually from VS 50 downstream to VS 12 with condition 2. This deposition increase is reflected in the loss of transport capacity as shown in Table C. The high bedload trap efficiency of floodwater retarding structures (fwrs) and increased duration of flow reduces bedload deposition and suspended load down to VS 50, but as the level of control by fwrs decreases downstream from this point, bedload deposition increases. Suspended sediment load is reduced from 54 percent at VS 135 to 17 percent at VS-12.

Table D shows that the effectiveness of watershed projects also has parallel results when applied to the reduction in gross erosion by either the future condition or the recommended Hatchie River Basin Land Treatment Plan.

The results of the study are based on a fixed set of data for the amount of gross erosion and watershed projects presently operational and projected to be completed as planned. Gross erosion and sediment deposition can vary significantly as a result of variables affecting agricultural programs or installation of watershed projects. However, definite trends are identified in the base data and projected future conditions. These are as follows:

1. Upland gross erosion is excessive throughout the basin with cropland being the major contributor.

2. Sediment volume derived from erosion and delivered to the stream system, exceeds stream transport capacity on tributaries and the main stream.

3. Watershed projects effectively reduce sediment deposition within project boundaries and on the main stem from VS 135 to VS 50, but have little effect downstream from VS 50.

4. The large volume of channel erosion in the Porters Creek project offset main stream sediment reductions which should have occurred. Channel erosion may be the result of effective erosion reduction and sediment detention within the project area.

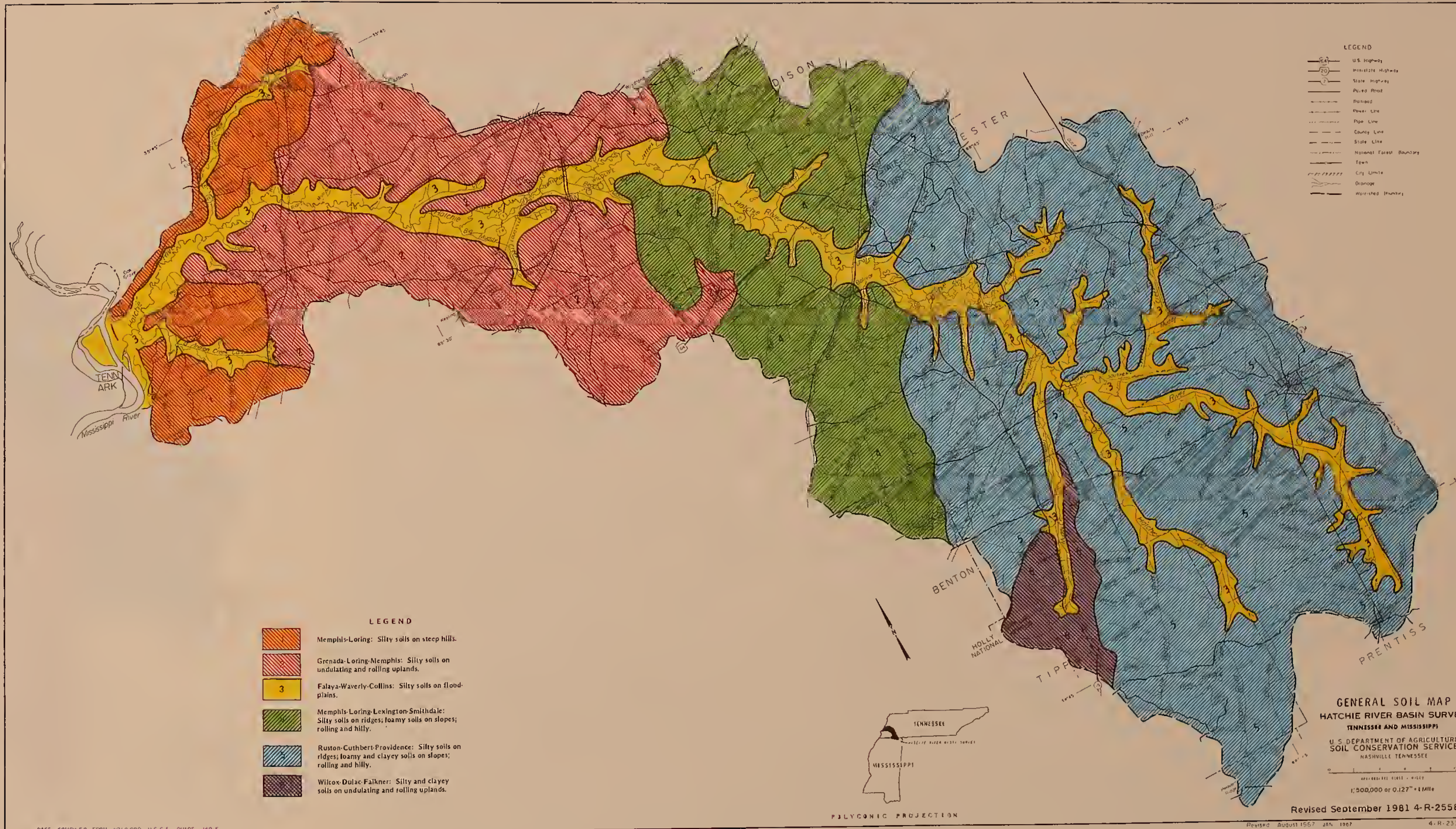
5. The 9 percent reduction in erosion estimated for future ongoing projects is not sufficient to prevent continued channel aggradation. This channel filling will result in water table elevation and cause swamping of flood plain land. Damages to crops, pastures and, particularly, timber from swamping and impaired drainage can be expected to greatly increase.

6. An intensive effort will be required to reduce gross erosion by at least 65 percent to reverse the sedimentation process now underway.

APPENDICES

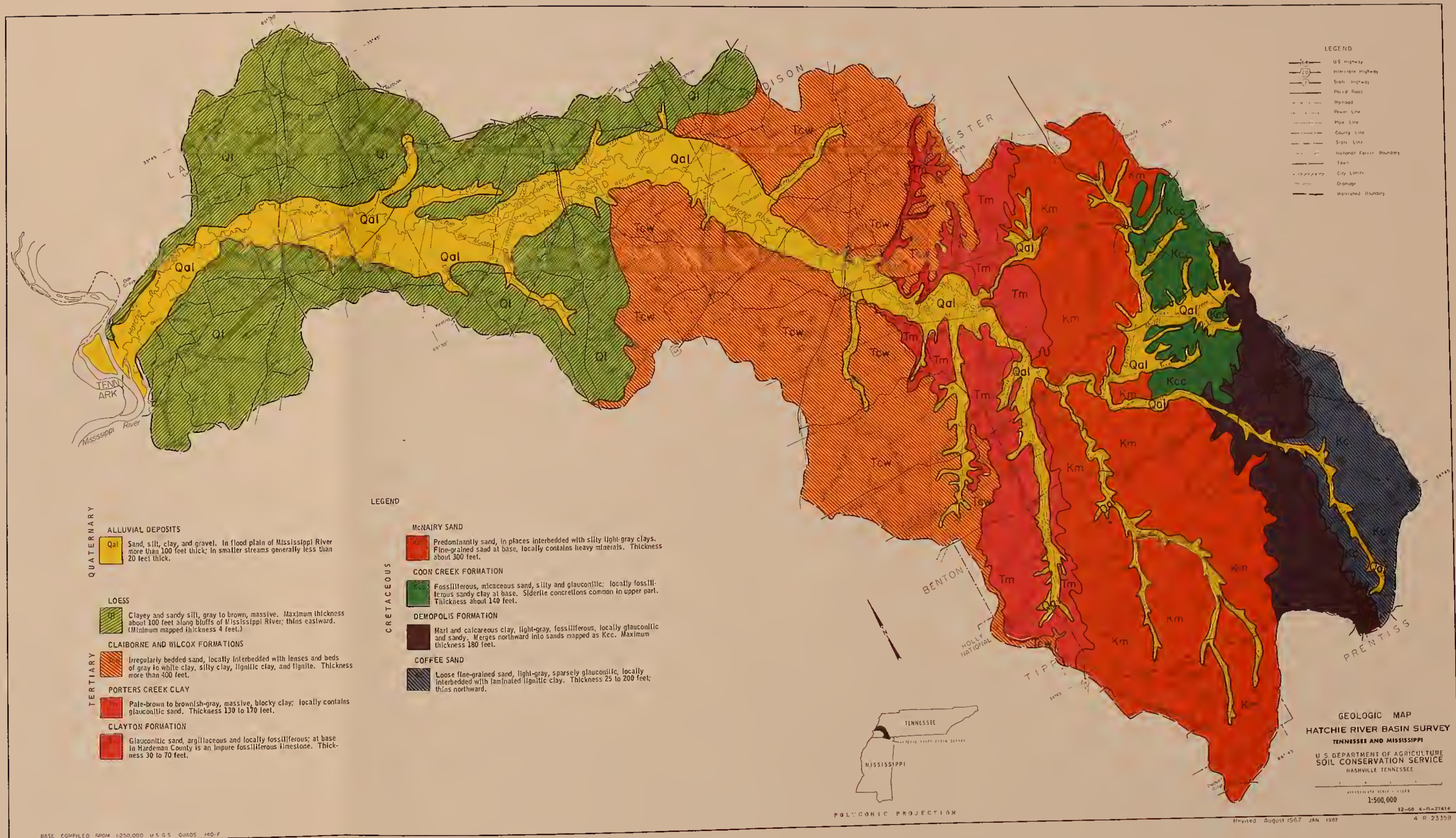
APPENDIX A

MAPS



Revised August 1967 JAN 1967 4-R-23358

USDA-SCS-FORT WORTH, TEXAS 1981



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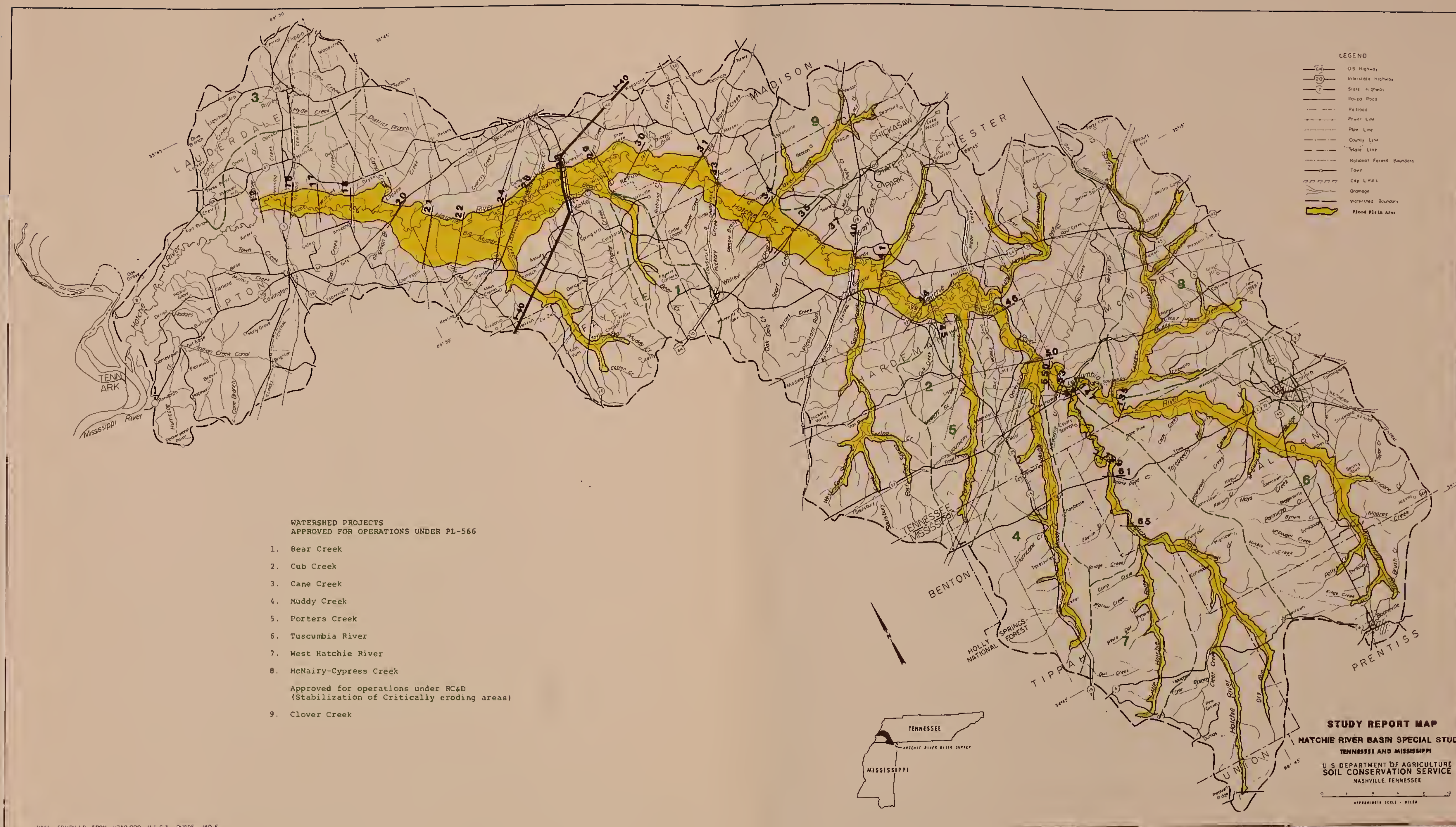


LEGEND
U.S. Highway
Interstate Highway
State Highway
Paved Road
Railroad
Power Line
Pipe Line
County Line
State Line
National Forest Boundary
Town
City Limits
Drainage
Watershed Boundary
Flood Plain Area
WATERSHED PROJECTS
APPROVED FOR OPERATIONS UNDER PL-566
1. Bear Creek
2. Cub Creek
3. Cane Creek
4. Muddy Creek
5. Porters Creek
6. Tuscumbia River
7. West Hatchie River
8. McNairy-Cypress Creek
Approved for operations under RC&D
(Stabilization of Critically eroding areas)
9. Clover Creek
LAUDERDALE
TIPTON
FAYETTE
HARDEMAN
MADISON
CHESTER
McNAIRY
ALCORN
TIPPAH
BENTON
UNION
PRENTISS
CHICKASAW STATE PARK
HOLLY SPRINGS NATIONAL FOREST
TENNESSEE
MISSISSIPPI
Hatchie River
Mississippi River
TENN
ARK
STUDY REPORT MAP
HATCHIE RIVER BASIN SPECIAL STUDY
TENNESSEE AND MISSISSIPPI
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NASHVILLE, TENNESSEE
BASE COMPILED FROM 1:250,000 U.S.G.S. QUADS 140-F
Revised August 1967 JAN 1967
4 R 23358

APPENDIX B

SUPPORTING DATA

GLOSSARY

Aggradation - The level or slope of a stream bed built up by the deposition of sediment.

Bed Load - Material moving on or near the stream bed by rolling, sliding and making brief excursions into the flow a few diameters above the bed.

Capability Class and Subclass - A practical grouping of soils where soil characteristics and climate are considered together as they influence use, management and production of general farm crops. Classes designated as I through VIII indicate increasing hazards and limitations to safe and economic use. Subclasses show the principal kinds of problems involved - "e" for erosion, "w" for wetness, "s" for slope and "c" for climate.

Degradation - Lowering a land surface or stream bed by erosion.

Dispersion - The percentage of clay size fraction or colloidal size soil particles which act as separate individual bodies. (The stability of soil aggregates when exposed to water.) When such particles adhere to one another to form relatively larger particles, they are known as flocs. Dispersed soils are unstable in water; go into suspension easily; are highly erodible; have low shear strength and have high piping potential. They also when wet have no bonding attraction and may actually repel one another.

dd SEC - Duration of flow in seconds for the 2.33-year storm hydrograph to pass through the selected reach.

Ephemeral Gullies - Areas of channelized flow that develop during the growing season, after harvest or after significant rain storm events. They are normally obscured by tillage operations but reappear during the next cropping season. They grow larger and deeper over time and form intermediate water courses or connecting channels between rill erosion and head cutting nonformable gullies.

Future Condition - Projected estimated land use and gross erosion for conditions 25 years hence from the base line data (1982).

Infertile Deposition - Modern sediment deposits on flood plains or colluvial soils from culturally accelerated erosion. Usually in the form of overbank splays, fans or vertical accretion deposits which are less productive than underlying soils. Usually in the form of sand, gravel, boulders or subsoil silts and clays and low in nutrient value.

National Resource Inventory (N.R.I. - 1982) - The inventory was initiated by Congress under the Resource Conservation Act of 1977. The Act is designed to provide for the appraisal of the Nation's soil, water and related resources. The National Resources Inventory will be continuously updated at 5-year intervals.

Hatchie River Basin Land Treatment Plan - An accelerated land treatment plan that was developed for the Hatchie River Basin as a part of the Hatchie River Basin Special Study.

PPM - Parts per million or milligrams per liter of sediment in water.

Present Condition - Present (1982) land use and erosion.

Resource Protection Plan Alternative - Most cost effective plan (with the confines of the incremental economic analysis) which achieves an acceptable level of resource protection.

Sediment Transport Equations - Empirical formulas developed from flume studies by a number of investigators that result in a procedure to determine the rate of bedload transport.

Stream Equilibrium - Bed material is introduced into a stream reach at a rate comparable to that at which bed material moves out of that reach.

Stream Miles - For purposes of this study, stream miles are measured from VS 135, which is at the Tuscumbia River Watershed.
Stream Reach - Distance from a valley section (VS) to a valley section downstream.

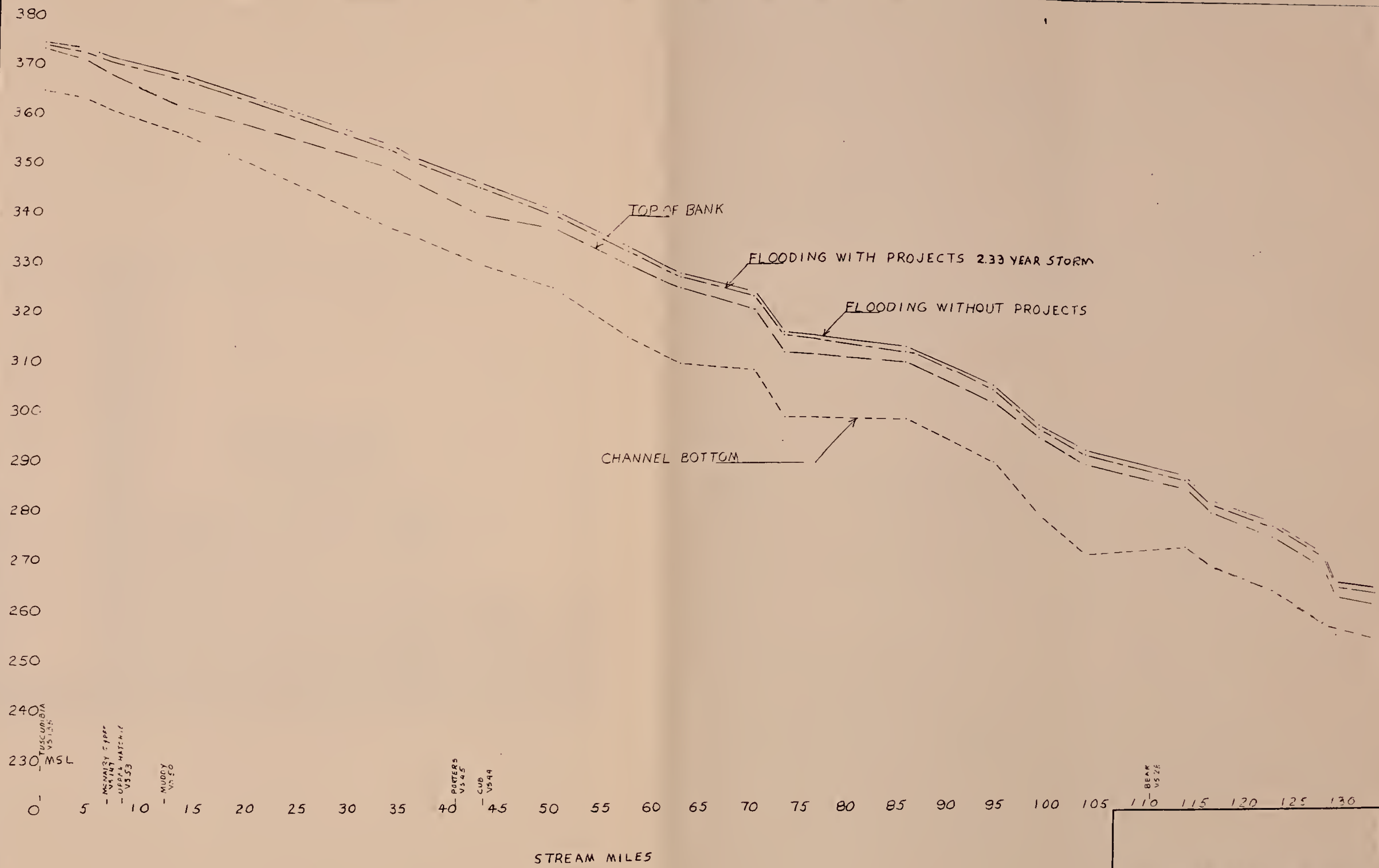
Stream Regime - Channels which do not alter appreciably from year to year -- though they may vary during the year. "Regime" is essentially the same as stream equilibrium.

Suspended Load - That part of the total sediment load that moves above the bed layer. The weight of suspended particles is continuously supported by fluid.

Swamping - Impairment of drainage of bottomland or colluvial soils by sediment deposits resulting from accelerated cultural erosion. Usually caused by filling of stream channels which raises the water tables on bottomlands or formation of natural levees by modern sediments which prevent proper surface drainage.

Trap Efficiency - The amount (percentage) of the sediment delivered to a reservoir that remains in it.

Valley Sections (VS) - Surveyed lines across a stream valley and channel and referenced to mean sea level (MSL).



HATCHIE SPECIAL STUDY

CHANNEL PROFILE

FIGURE 3

SCS-ENG-313-9 Rev. 10-75

HATCHIE SPECIAL STUDY

DEPOSITION BY REACHES

FIGURE 4

HATCHIE SPECIAL STUDY

DEPOSITION BY REACHES

FIGURE 5

HATCHIE SPECIAL STUDY
DEPOSITION BY REACHES
N.E.D. ALTERNATIVE

FIGURE 6